Public Health Service

DEPARTMENT OF HEALTH & HUMAN SERVICES
Centers for Disease Control and Prevention (CDC)

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From: Foodborne and Diarrheal Diseases Branch
Division of Bacterial and Mycotic Diseases, NCID

Subject: Shiga toxin-producing *Escherichia coli*: Data from 2002 and recommendations on reporting

To: State and Territorial Epidemiologists,
State and Territorial Public Health Laboratory Directors

As a result of advances in diagnostic testing, there have been increased opportunities to diagnose infections caused by Shiga toxin-producing *Escherichia coli*, including serogroups O157 and non-O157. This memo provides recommendations to clinical laboratories and public health organizations on diagnostic testing and reporting. Also included is an attached summary report "Shiga toxin-producing *Escherichia coli*–United States, 2002" which provides CDC data on Shiga toxin-producing *E. coli* (STEC) isolations and cases for 2002.

E. coli O157:H7 was made nationally notifiable in 1994. In 2000, the Council for State and Territorial Epidemiologists (CSTE) adopted a position statement (2000 ID#1) for the inclusion of illness due to enterohemorrhagic *E. coli* (EHEC) as a nationally notifiable disease. Illness due to *E. coli* O157:H7 as well as non-O157 STEC, was subsumed under EHEC surveillance starting in 2001.

The change in surveillance definitions is in response to the changing diagnostic capacity of clinical and public health microbiology laboratories. Confirmation of *E. coli* O157:H7 has traditionally relied on culture techniques that capitalize on that organism's limited ability to ferment sorbitol (unlike most other *E. coli*, including most non-O157 STEC). Culture was the basis of confirming *E. coli* O157:H7 infection in the previous CSTE definition.

In 1995, FDA licensed the first of several rapid diagnostic assays capable of detecting Shiga toxin in stool specimens or culture broth. These non-culture tests are capable of detecting the presence of *E. coli* O157:H7 and non-O157 STEC. Increasingly, clinical laboratories are relying on these tests rather than on culture to detect infection with *E. coli* O157:H7 as well as other STEC, thus the case definition required amendment to accommodate these changes in clinical laboratory practice. The CSTE case definition for EHEC is available at: http://www.cdc.gov/epo/dphsi/casedef/escherichia_coli_current.htm.

Health care providers evaluating patients with diarrhea or HUS should consider infection

with non-O157 STEC in addition to *E. coli* O157. A small number of persons have developed HUS after urinary tract infection with STEC strains; in these cases, urine culture has yielded the pathogen when stool culture was negative.

We recommend that clinical laboratories add Shiga toxin testing with assays such as EIA to the microbiological tests they offer. Appropriate specimens for Shiga toxin testing include stools from persons with diarrhea (especially bloody diarrhea) or HUS, and sterile-site isolates of *E. coli* from persons with HUS. Clinical laboratories can use O157 antisera to determine which STEC are O157. Identifying *E. coli* O157 at the clinical laboratory level should be routine for diarrhea stools; rapid reporting of *E. coli* O157 isolates to health departments is critical in detecting outbreaks.

The use of non-culture assays allows the rapid detection of many serogroups of STEC pathogens-- a clinical and public health advance. However, it remains imperative that a cultured isolate be obtained for the purposes of confirmation and characterization. Isolate serotypes and genotypes are essential for surveillance, outbreak detection and investigation. Thus, laboratories using only non-culture assays should consult with their state or local public health laboratory to determine preferred methods and requirements for additional testing or submission of specimens found to be Shiga toxin-positive by rapid assay. This issue is addressed in CSTE position statement (2000 ID#4), which may be viewed at http://www.cste.org/ps/2000/2000-id-04.htm.

Most laboratories are unable to serotype STEC other than O157:H7. To accomplish complete serotyping, please forward isolates of suspected or confirmed non-O157 STEC to the National *Escherichia coli* Reference Laboratory, c/o:

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Rapid referral of isolates for serotyping and characterization will aid in timely surveillance results. We therefore suggest that isolates not be batched for submission.

Please note that at present, the Public Health Laboratory Information System (PHLIS) is the only national surveillance system which collects specific O and H antigen serotypes for STEC. Therefore, it is important to report all STEC isolates via PHLIS in order to achieve specific surveillance for non-O157 serogroups. As noted in the following report, a number of non-O157 STEC isolates confirmed and serotyped at the National *Escherichia coli* Reference Laboratory were not reported in the PHLIS system.

Though the National Notifiable Diseases Surveillance System (NNDSS; also known by the acronym NETSS) does not collect specific serotype information, three reporting categories are provided: 1) *E. coli* O157:H7, 2) Shiga toxin-producing *E. coli*, serogroup non-O157, and 3) Shiga toxin-producing *E. coli*, not serogrouped. Surveillance data from NNDSS is published each week in the Morbidity and Mortality Weekly Report (MMWR) and in the

MMWR annual Summary of Notifiable Diseases. MMWR reports no longer include PHLIS data.

Surveillance for Shiga toxin-producing *E. coli* is advancing as laboratories increase their ability to detect and identify these important organisms and as reporting becomes more complete. Thank you for your continued interest and contributions.

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Escherichia coli O157:H7 infection, along with non-O157:H7 Shiga toxin-producing *E. coli* (STEC) infection, may cause diarrhea and hemorrhagic colitis. These infections are also the leading cause of the hemolytic uremic syndrome (HUS), characterized by microangiopathic anemia, thrombocytopenia and renal insufficiancy. The most common STEC that causes illness in the United States is *E. coli* O157:H7. Non-O157 STEC are also important pathogens; they have caused several U.S. outbreaks and, in some U.S. studies, have been isolated from diarrheal stools as frequently as *E. coli* O157:H7. However, not all STEC strains are human pathogens; STEC strains that cause diarrhea or HUS comprise the enterohemorrhagic *E. coli* (EHEC).

This report summarizes CDC surveillance and laboratory data for STEC. The data sources consist of: 1) laboratory-confirmed cases in the National Notifiable Diseases Surveillance System (NNDSS) (also referred to as the National Electronic Telecommunications System for Surveillance or NETSS), 2) the Public Health Laboratory Information System (PHLIS), and 3) isolates received at the Centers for Disease Control and Prevention's National *Escherichia coli* Reference Laboratory. NNDSS and PHLIS are national surveillance systems designed to collect national case and laboratory surveillance data for notifiable diseases. A major distinction between these two systems is that PHLIS collects reports of isolates confirmed at the state laboratories of public health and includes specific O and H antigen information, while NNDSS collects case data for which isolates may not be confirmed at state laboratories and does not include specific O and H antigen data. CDC's National *Escherichia coli* Reference Laboratory provides confirmation tests to identify STEC, serotyping of O and H antigens, and molecular characterization of Shiga toxins and other virulence factors as a service to state and local public health laboratories. Though not a surveillance system, we report the number of isolates received as one of the most complete assessments of non-O157 STEC with specific serotype information.

Before 2001, only *E. coli* O157 was nationally notifiable. The increased number of reported *E. coli* O157 isolates or laboratory-confirmed cases reported to PHLIS and NNDSS, respectively, every year before 2001 was possibly associated with increased reporting in a maturing surveillance system. However, the numbers for both systems decreased in 2001 (Figure 1).

PHLIS data from 2001 included 2,687 STEC isolates from 46 states; NNDSS included 3,155 culture-confirmed enterohemorrhagic *E. coli* cases from 49 states (Table 1); Puerto Rico also reported two cases.

Among the isolates reported to PHLIS were 65 (2%) STEC among serogroups other than O157 from seven states; NNDSS included 166 (5%) non-O157 STEC from 22 states (Table 2). The CDC National *Escherichia coli* Reference Laboratory received a greater number of non-O157 STEC case-isolates than were reported in either

surveillance system -- 188 from 28 states (Figure 2).

The non-O157 isolates received by the National *Escherichia coli* Reference Laboratory in 2001 included 26 different O groups. The predominant groups were O26 (26%), O103 (16%), and O111 (15%), followed by O45 (8%) and O121 (5%); these five O groups comprised 70% of all isolates (Table 3). *E. coli* O26 was the most commonly isolated non-O157 STEC in 2001, whereas O111 was most common in 2000. The same serotypes ranked in the top five for both 2000 and 2001.

Reported STEC infections tend to occur in younger persons. In 2001 in PHLIS and NNDSS respectively, 27% and 26% of STEC cases were among children 0-5 year of age and the median age was 15 and 17 years. Among 115 non-O157 STEC isolates from patients with age data available in the National *Escherichia coli* Laboratory database, the case-patients tended to be even younger; 38% were 0 to 5 years old with a median age of 10 years. There was approximately equal distribution among males and females in all three databases.

In 2001, as in previous years, more (42% to 56%) STEC isolates were collected during the warm months, July through September, than during any other quarter. The etiology of the summer surge for *E. coli* O157:H7 infections is likely multi-factorial, but may be partially attributed to events whereby large numbers of susceptible children congregate in close association with other infected persons and with animal reservoirs for *E. coli* O157:H7 and poorly maintained and regulated pools, water distribution systems and washing facilities such as in some water parks, petting zoos, and agricultural fairs. In 2000 and 2001, CDC assisted state and local health departments in the investigation of several outbreaks of *E. coli* O157:H7 infections at petting zoos and county fairs and proposed recommendations to reduce the risk for transmission of enteric pathogens in settings where the public has contact with farm animals (1,2).

References

1. Centers for Disease Control and Prevention. Outbreak of *Escherichia coli* O157:H7 infections among children associated with farm visits– Pennsylvania and Washington, 2000. MMWR 2001;50:6-8.
2. Crump JA, Sulka AC, Langer AJ, et al. An outbreak of *Escherichia coli* O157:H7 infections among visitors to a dairy farm. N Engl J Med 2002;347:555-560.

Table 1. Number of Shiga toxin-producing *E. coli* isolates, by state, 2002

Public Health Laboratory Information System (PHLIS) and the National Notifiable Diseases Surveillance System (NNDSS)

State	PHLIS* Number	NNDSS** Number
AK	6	1
AZ	-	40
CA	218	-
CO	45	57
CT	28	-
DC	-	3
DE	8	-
FL	58	77
GA	41	55
HI	-	26
ID	21	63
IL	-	194
IN	-	88
KS	9	40
KY	21	39
LA	3	1
MA	30	93
MI	114	27
MN	179	98
MO	15	175
MS	5	11
NC	30	218
ND	9	-
NE	-	5
NH	3	27
NJ	1	-
NM	8	-

NV	-	23
OH	128	13
OR	8	-
PA	-	148
RI	14	1
SD	1	41
TN	9	23
UT	91	-
VA	71	-
VT	12	-
WI	-	296
WV	12	-
WY	1	-
Total	**1199**	**1883**

* Public Health Laboratory Information System- includes STEC isolates confirmed and reported by state public health laboratories
**National Notifiable Diseases Surveillance System- includes laboratory-confirmed STEC cases in three categories: *E. coli* O157, Shiga toxin-producing *E. coli*, serogroup non-O157, and Shiga toxin-producing *E. coli*, not serogrouped. Cases reported in NNDSS may not have isolates forwarded and confirmed at the state laboratory, which may account for some inconsistancy between surveillance systems.
†This total does not include 2 reported cases from Puerto Rico.

Table 2. Comparison of number of non-O157 Shiga toxin-producing *E. coli* from three data sources, 2001

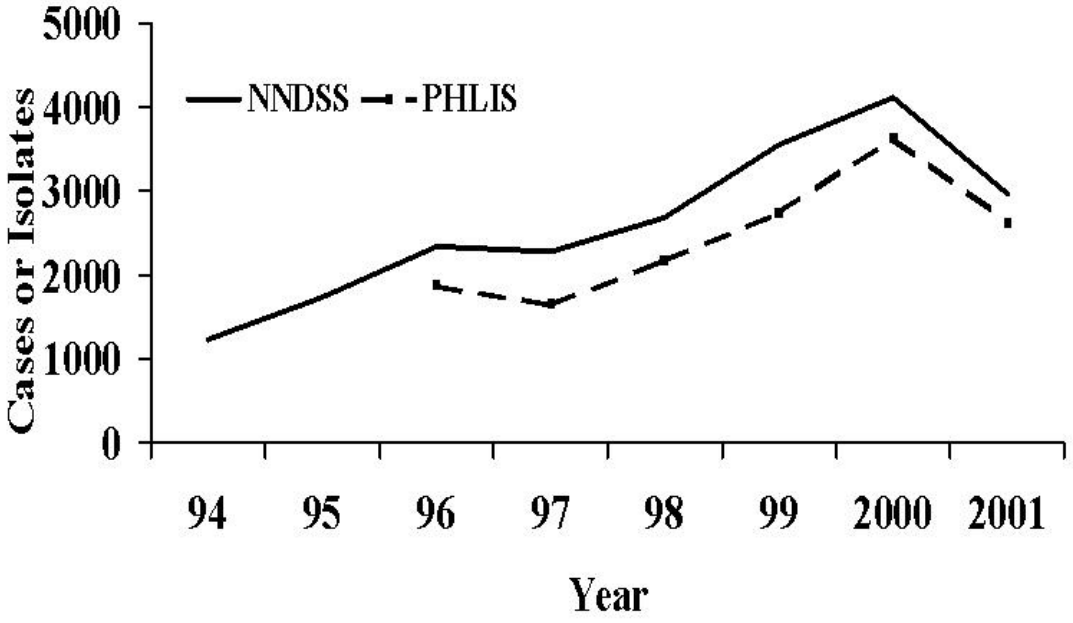
Source	Number of non-O157 STEC
Public Health Laboratory Information System (PHLIS)	65
National Notifiable Diseases Surveillance System (NNDSS)*	166
Isolates referred to National *Escherichia coli* Reference Laboratory, CDC	188

*Laboratory-confirmed isolates from surveillance category "*E. coli*, Shiga toxin-producing, serogroup non-O157". NNDSS does not include specific serogroup information. In addition, there were 19 reports of Shiga toxin-producing *E. coli*, not serogrouped.

Table 3. Serogroup of 188 Non-O157 STEC Isolated from Humans and sent to the National *Escherichia coli* Reference Laboratory, CDC
January 1, 2001 - December 31, 2001

Serogroup	Number (%)
O26	49 (26)
O103	30 (16)
O111	29 (15)
O45	15 (8)
O121	9 (5)
O145	8 (4)
O118	5 (3)
O165	3 (2)
O22	2 (1)
O128	2 (1)
O146	2 (1)
O6	1 (<1)
O28	1(<1)
O51	1 (<1)
O60	1 (<1)
O88	1 (<1)
O91	1 (<1)
O109	1 (<1)
O110	1 (<1)
O113	1 (<1)
O116	1 (<1)
O126	1 (<1)
O142	1 (<1)
O153	1 (<1)
O159	1 (<1)
O174	1 (<1)
rough	11 (6)
undetermine	8 (4)
Total	188 (100)

Figure 1. *E. coli* O157* in the United States, 1994-2001
Public Health Laboratory Information System (PHLIS) and
National Notifiable Diseases Surveillance System (NNDSS



*Only isolates with H7 antigen or which produce Shiga toxin are considered pathogens and reported

Figure 2. States that Submitted Non-O157 STEC to CDC, 2001
(29 States; Number=isolates submitted)


12
6
4
3
1
5
24
8
2
4
7
4
6
32
1
5
2
1
5
4
6
1
4
4
MA=9
RI=1
CT=21
NJ=1
MD=5